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Employment Outlook in

ELECTRONICS MANUFACTURING

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UNITED STATES DEPARTMENT OF LABOR
Maurice J. Tobin, *Secretary*

BUREAU OF LABOR STATISTICS
Ewan Clague, *Commissioner*

In cooperation with
VETERANS ADMINISTRATION

LETTER OF TRANSMITTAL

United States Department of Labor,
Bureau of Labor Statistics,
Washington, D. C., February 21, 1952.

The Secretary of Labor:

I have the honor to transmit herewith a report on the employment outlook in electronics manufacturing occupations. This is one of a series of reports based on studies conducted in the Bureau's Occupational Outlook Service for use in vocational counseling of veterans, young people in schools, and others interested in choosing a field of work. These reports describe the Nation's needs for trained workers in each major industry and occupation under the defense mobilization program. The study was financed largely by the Veterans Administration, and the report was originally published as a Veterans Administration pamphlet for use in vocational rehabilitation and education activities.

The study was prepared by Stuart A. Pettingill with the assistance of William Shickler. The Bureau wishes to acknowledge the generous assistance received from unions, trade associations, electronics companies, and from other Government agencies.

Ewan Clague, *Commissioner.*

Hon. Maurice J. Tobin,
Secretary of Labor.

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EMPLOYMENT OUTLOOK IN ELECTRONICS MANUFACTURING

The Electronics Industry

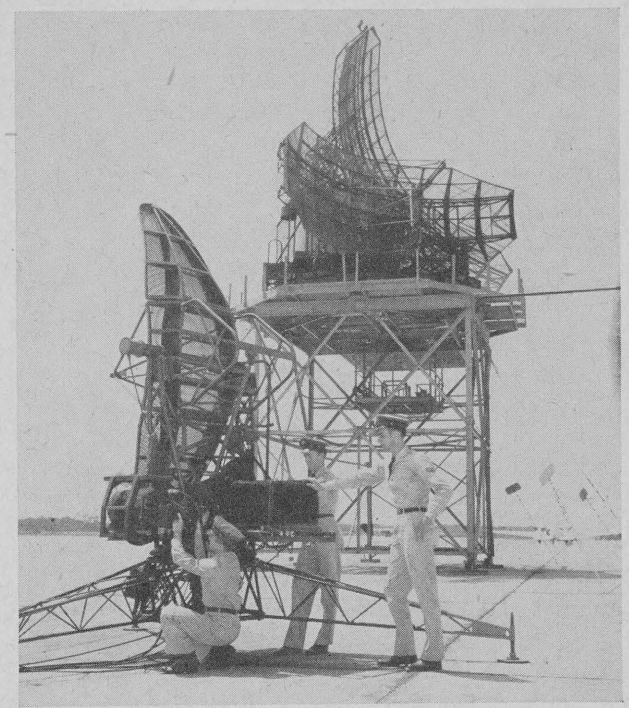
The young and rapidly growing electronics industry employed 280,000 workers in the manufacture of electronics products in October 1951. Electronics manufacturers produced military and commercial products worth $2½ billion and parts and tubes worth another half billion in 1950. Although the peacetime use of electronics equipment is best typified by the familiar radio and television set, electronics equipment is also vital in modern warfare. The Armed Forces require large quantities of radio and radar equipment for communications, air warning, navigation, and many other purposes. Present defense programs call for expanded military purchases of radio and radar equipment which will be added to the civilian demand for radio and television sets and other civilian electronics products. As a result, many additional electronics workers may be needed during the next 2 years.

Any device which uses gaseous or vacuum tubes is considered electronic. The electronics industry includes manufacturers of home radio and television receivers; military, commercial, and industrial radio and radar equipment; and their component parts and tubes. The industry is often divided into two parts for purposes of statistical reporting: (1) Radio, television, and related products manufacturing; and (2) electron tube manufacturing. But electronics is more than a class of products or a group of manufacturing industries. It is really an applied science utilizing certain basic mechanical and electrical principles. Application of these principles has already given birth to radio and television broadcasting, international radio communication, and other industries. Future developments will probably create other industries or materially affect existing ones. Appendix I (p. 24) lists the widespread uses of electronics products.

The aircraft, telephone equipment, and other manufacturing industries now produce appreciable amounts of electronics equipment. Employment opportunities in the electronics industry are so closely related to opportunities in other industries manufacturing electronics products that they cannot be considered separately.

The electronics industry came into being after the First World War although successful trans-Atlantic radio communication had been accomplished at the turn of the century. The invention and improvement of vacuum tubes permitted a more widespread use of radio communications, and radio was used widely for military communications during the First World War. Before that

Air Forces radar unit used for air traffic control and air warning.



time, radio communications had been largely confined to maritime use. Radio broadcasting began in November 1920, and in the following years broadcasting stations sprang up all over the United States. The demand for home receiving sets created a new industry and large firms developed that specialized in their manufacture. Commercial, industrial, and military electronics manufacturing also increased steadily during this period. The Second World War, with its mammoth need for military electronics equipment, brought about an increase in the amount and variety of output. Although employment and production dropped sharply after the war, the introduction of television stimulated another cycle of expansion. By the end of 1950, the industry's total value of output had almost returned to the wartime peak.

Although electronics products have a wide variety of commercial, industrial, and military uses, they can be divided into four major groups: (1) Radio and television receiving sets; (2) commercial, industrial, and military electronics equipment; (3) component parts; and (4) electron tubes.

In peacetime, more workers are employed in the manufacture of receiving sets—and their parts and tubes—than of any other electronics product. Relatively few are employed in military, industrial, and commercial electronics manufacturing, which includes radio and television broadcasting transmitters, motion-picture sound equipment, commercial receiving equipment, military radio and radar equipment, test equipment, and many other electronics products. During periods of rearmament or wartime, however, employment in the manufacture of these products increases sharply.

Employment in the manufacture of parts and electron tubes depends upon the amount of complete electronics equipment produced, because most components are used in fabricating new equipment. More than a third of all electronics workers are normally engaged in parts or tube manufacture.

Some electronics manufacturing firms specialize in making home receiving sets, tubes, or parts, whereas others make both finished equipment and components. Several large producers of home radio and television sets merely assemble purchased parts and tubes. Many firms manufacture only specialized industrial, commercial, or military equipment or parts. Electronics manufacturing is only a side line for some aircraft, automobile, refrigeration, and electrical equipment manufacturers. Some electronics manufacturers, however, also make other products.

Medium- and large-size firms employ the great majority of electronics workers. In 1947, less than 10 percent of the industry's workers were employed in establishments with fewer than 100 workers, and over half the industry's workers were in plants employing over 1,000 workers.

Electronics workers are heavily concentrated in the Chicago, New York, and Philadelphia metropolitan areas. More than a third of all electronics workers were employed in these areas in March 1951 including almost half the workers engaged in manufacturing radio and television sets. At the same time, almost a third of all parts workers were employed in the Chicago and Philadelphia metropolitan areas and over a third of all electron tube workers were employed in the New York and Boston metropolitan areas.

TABLE 1.—*Concentration of electronics employment in metropolitan areas, March 1951*

Metropolitan area	Percent of total employment
Total	100.0
Chicago, Ill	13.6
New York, N. Y.; Newark, N. J	12.7
Philadelphia, Pa.; Camden, N. J	10.3
Boston, Mass	5.6
Indianapolis, Ind	4.0
Syracuse, N. Y	3.7
Los Angeles, Calif	3.0
Fort Wayne, Ind	2.1
Baltimore, Md	1.9
Buffalo, N. Y	1.9
Paterson-Passaic, N. J	1.7
Cincinnati, Ohio	1.4
Milwaukee, Wis	1.1
Cleveland, Ohio	1.0
All others	36.0

How Electronics Products Are Made

Processes in electronics manufacturing vary from plant to plant because of the wide range of products. The principal peacetime electronics products are mass-produced by manufacturing methods similar to those of other industries. However, some complex specialized military, commercial, and industrial equipment and components are made to order in small quantities.

Radio and television receivers are made on assembly lines where each worker performs a highly specialized task. The majority of receiver manufacturers purchase their parts and tubes from other manufacturers. After these components are received, they are often spot tested before being sent to the various assembly stations. In general, receivers in various stages of completion move down the assembly line, which may be a continuous moving belt or simply a long bench upon which sets are pushed from one worker to another. The chassis (the metal box to which most components are attached) is usually stamped out of sheet metal and some parts are riveted to it in a subassembly line or room. After the chassis is prepared, it starts down the main assembly line where other parts are attached, wired, and soldered. At frequent intervals, it is inspected and tested for proper assembly and electrical wiring.

Quality control (the periodic testing and inspection of a product to see if it is being made according to specifications) is extremely important in electronics manufacturing and increases with the complexity and quality of product. Most assembly operations are highly specialized and performed with great rapidity, and all operations are carefully timed to maintain a continuous production flow.

As the chassis moves down the assembly line, parts are placed or timed to reach the assembler when needed. Small parts are often "hopper fed" into boxes by the side of the assemblers. Large parts move by overhead conveyor or are carted, depending upon the size of plant or the quantity ordered. Some assemblers attach small parts, and others add wires or solder connections. Operations are subdivided as much as possible and workers are assisted by models, diagrams, and color coding of parts and wires. The degree of specialization depends upon the size of plant and type of product.

At the end of the line, tubes are added and the receiver is adjusted and tested as a unit. Inspectors and testers check its quality and, in some television firms, operate it for a while to see if defects develop. Defective units are shunted aside to skilled all-round "trouble shooters" who locate and correct the difficulty. After receiving final inspection, completed receivers are placed in cabinets (which are purchased or made in other departments) and sent to the shipping department to be crated for storage or shipment. Chart 1 illustrates the organization of production in a typical television manufacturing plant.

Behind this mechanized flow lies much engineering. In such a highly competitive industry, the elimination of even a single part or wasted motion saves time and cost when multiplied by thousands of sets. This high degree of production planning makes electronics manufacturing an engineer's industry.

Electronics equipment more complex than receiver sets is produced in smaller quantities, with similar production techniques but with decreasing mechanization and worker specialization as the

Skilled workers on a television assembly line.

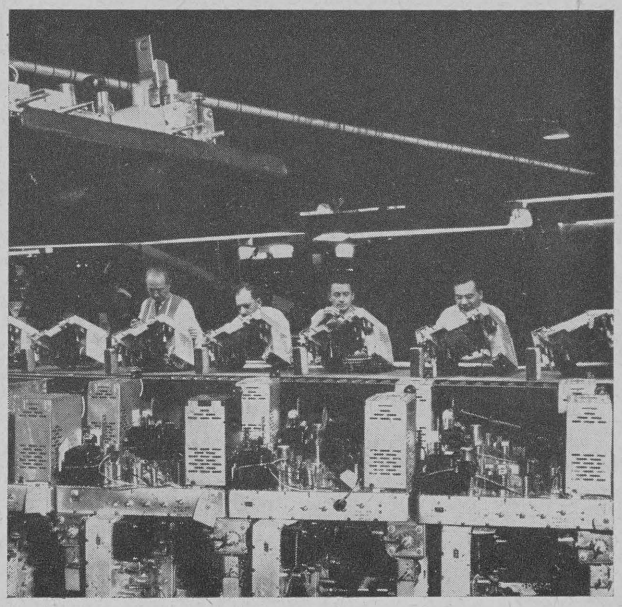


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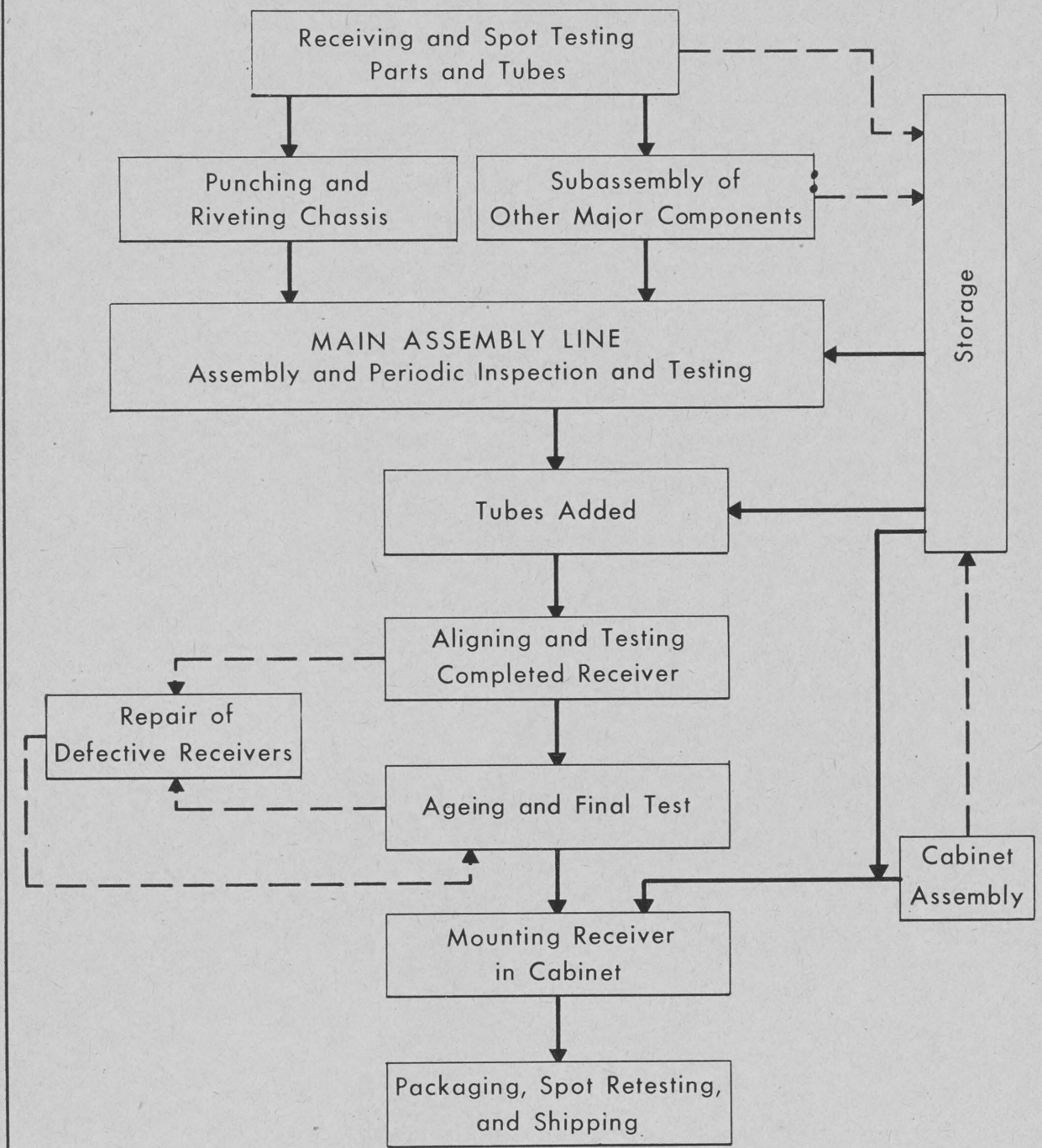
Chart 1. PRODUCTION FLOW IN TELEVISION MANUFACTURING



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unit volume declines. Custom-made products require more skilled labor. Large military and commercial units are often broken down into subassemblies which are built separately and then assembled and tested as a unit. Many types of military equipment operate on extremely high frequencies where radio waves have properties similar to light waves. The electrical adjustment of such equipment is extremely critical and requires precision manufacture. Some of the components associated with radar, such as metal waveguides, must be machined or cast with the greatest precision.

Even when military equipment is produced by assembly-line methods, the work is quite different than for receiver manufacture. Assembly workers on military electronics products perform more operations and must be able to follow more detailed diagrams and instructions. Because accuracy is more important than speed, the work pace is not as rapid as in the making of receiver sets.

The manufacture of standard parts, such as capacitors, resistors, transformers, and coils, is on a large-volume, mass-production basis, and usually involves relatively simple production processes.

Tube manufacturing is highly mechanized. Much semiautomatic and automatic machinery is used except for special purpose tubes made in relatively small quantities. Receiving tube manufacturers employ an even greater proportion of semiskilled and unskilled assembly workers than home radio and television manufacturers. On the other hand, some specialized transmitting tubes such as klystrons and magnetrons require considerable precision metalworking. Plants making this type of tube use many skilled workers.

Tube manufacture usually includes the following steps: (1) Receiving of materials; (2) fabrication of the parts of the tube from these materials; (3) their assembly into the completed elements of the tube; (4) mounting of these elements into the tube base; (5) sealing the glass bulb into the base; (6) removing the air from inside the tube; (7) final testing; and (8) packaging and shipping. Quality control is maintained by frequent inspection and testing throughout.

An inspection operation in television tube manufacturing.

Electronics Workers

The great majority of workers engaged in making radio and television sets, parts, and electron tubes are either semiskilled or unskilled assembly workers. However, some parts of the industry need more skilled workers than others.

Radio and television receiver manufacturers employ few workers in such skilled occupations as tool-and-die making, inspection, and trouble-shooting. Some firms assemble only purchased parts and often pay other firms for doing their research and development. Such companies employ only a few professional workers who are engaged almost entirely in production engineering.

A few large integrated electronics manufacturing companies make all kinds of products and employ all types of electronics workers. They have extensive research and development organizations which employ engineers and scientists as well as technicians. Manufacturers of specialized military, commercial, and industrial equipment and components also engage in extensive research and development. Research and development engineers, draftsmen, electronic technicians, skilled machine-tool operators, machinists, die setters, and other skilled workers are required in greater proportion in the manufacture of military equipment than in other electronics manufacturing.

Assemblers performing specialized tasks on a radio-phonograph assembly line.

Some components require highly skilled labor and extensive research and development, but most components manufacturers employ fewer professional and skilled workers than do manufacturers of final products. For example, receiving tube manufacturers employ a larger proportion of plant workers than does the rest of the industry, and they also use a larger proportion of semiskilled and unskilled women assemblers. On the other hand, manufacturers of specialized military and industrial tubes employ more professional and skilled workers than do receiving tube manufacturers. Appendix II (p. 26) shows the proportion of workers in major occupational groups in radio, television, and related products manufacturing.

Approximately one out of five electronics workers are employed in office jobs and professional, executive, and administrative positions. The ratio of engineers to other employees is higher in electronics manufacturing than in most manufacturing industries. Also, draftsmen and other semiprofessional workers are employed in small numbers along with the engineers.

Three-fourths of the plant workers can be divided into nine major occupational groups (the remaining fourth being in miscellaneous jobs too detailed to classify conveniently) :

(1) *Assembly workers* make up the industry's largest occupational group. More than a third of all electronics employees are engaged in assembly tasks. These workers assemble parts, wire sets, wind coils, solder joints, mount parts, weave cables, and perform similar assembly tasks. Most of these workers are either semiskilled or unskilled, although some skilled workers are employed in these occupations in military and commercial equipment manufacturing.

(2) *Quality control and related workers* make up another large group. Workers engaged in inspection, testing, tuning, adjusting, calibrating, and trouble-shooting, comprise about a tenth of the industry's employees. These workers are closely connected with quality control and their proportion and skill vary widely with the type of product. A large proportion of the industry's inspectors and testers are semiskilled, but this occu-

pation also includes some of the industry's most highly skilled workers.

(3) Approximately 5 percent of the industry's workers are employed in *metalworking and tooling* occupations such as machine-tool operators, production machinists, tool-and-die makers, platers, and punch-press operators. The majority are semiskilled, although this group contains some of the industry's most highly skilled workers.

(4) *Miscellaneous processing workers*, such as painters and welders, comprise about 3 percent of the industry's labor force. As in assembly jobs, most of these workers are semiskilled or unskilled.

(5) *Foremen* compose about 2 percent of the workers. These are skilled or semiskilled workers who supervise less-experienced workers performing similar tasks.

(6) *Custodial workers*, such as janitors, guards, and watchmen, comprise less than 2 percent of the total employment. These jobs are very similar to their counterparts in other industries and are manned by unskilled or semiskilled workers.

TABLE 2.—*Percentage distribution of workers in electronics manufacturing, by occupation, January 1947*

Occupational group	Percent of total
Total	100.0
Office workers:	
Executive, administrative, and professional workers	7.7
Clerks, stenographers, and other office workers	12.5
Plant workers:	
Assemblers	29.3
Inspectors, testers, and electronic technicians	8.8
Metalworking and tooling workers	5.2
Miscellaneous processing workers	3.1
Working foremen	2.0
Custodial workers (guards, janitors, watchmen)	1.9
Maintenance workers	1.3
Materials handling workers	1.3
Plant clerical workers	1.1
Other plant workers	25.8

(7) *Maintenance workers*, such as highly skilled carpenters, electricians, machinists, mechanics, and millwrights, keep the plant and equipment in repair and install new machinery and other equipment. Less than 2 percent of all workers in the industry are employed in these occupations.

(8) *Materials-handling jobs*, such as packing and crating, goods receiving, and stockroom work, require a fairly large number of the industry's employees. Assembly firms require many workers to handle the numerous components. Some military and commercial equipment requires special packaging involving considerable labor. The great majority of these jobs are semiskilled or unskilled.

(9) Electronics manufacturing requires a number of plant *clerical workers* to keep stock records, check in supplies, and do other clerical work which can be done more efficiently in the plant than in the general offices of the company. These plant clerical workers comprise only 1 percent of all workers.

In September 1950, 58 percent of plant workers in radio, television, and related products manufacturing were women. In radio and television receivers and components manufacturing, a greater proportion of workers are women than in commercial and military electronics equipment manufacturing. In March 1950, two-thirds of the plant workers in electron tube manufacturing were women. This large proportion of women, who make up one of the chief reservoirs of labor, aids expansion during periods of general labor shortage.

The proportion of women employed in electronics production varies with general employment conditions. During periods of manpower stringency such as World War II, the proportion of women increased sharply. However, even then, the great majority were employed in semiskilled and unskilled jobs. Since the war, more women are in skilled jobs, but the proportion is still insignificant.

The "separation rate" (the number of workers who leave every month as a percentage of total employed) is customarily higher in this industry than in manufacturing as a whole (table 3). Although the industry is subject to periodic lay-offs, a large proportion of workers who leave quit voluntarily. It is fairly easy for workers to change jobs because the type of work is similar to other manufacturing. As in other industries, there is usually a large turn-over of women who leave work to raise families. These high turn-over rates create openings for new workers each year. Although some vacancies arise each year as older workers retire, fewer jobs are created by retirement in this industry than by other forms of turn-over.

TABLE 3.—*Labor turn-over rates in radio, television, and related products manufacturing compared with the all-manufacturing average, by month, 1950–51*

Year and month	All-manufacturing		Radio, television, and related products					
	Total accessions [1]	Total separations [2]	Total accessions [1]	Separation [2]				
				Total	Quits	Discharges	Lay-offs	Military and miscellaneous
1950: January	3.6	3.1	6.5	4.7	1.8	0.4	2.4	0.1
February	3.2	3.0	6.3	4.4	1.8	.5	2.0	.1
March	3.6	2.9	6.6	4.9	1.9	.5	2.3	.2
April	3.5	2.8	6.1	3.7	1.9	.4	1.3	.1
May	4.4	3.1	6.7	4.5	2.1	.5	1.7	.2
June	4.8	3.0	7.2	3.4	1.9	.4	1.0	.1
July	4.7	2.9	8.8	2.7	1.5	.5	.6	.1
August	6.6	4.2	12.7	4.1	3.0	.5	.3	.3
September	5.7	4.9	9.6	5.6	3.7	.9	.6	.4
October	5.2	4.3	9.0	6.2	3.9	1.1	.7	.5
November	4.0	3.8	5.4	5.9	3.4	.8	1.4	.3
December	3.0	3.6	2.9	6.1	2.5	.5	2.8	.3
1951: January	5.2	4.1	6.5	7.0	2.7	.6	2.5	1.2
February	4.5	3.8	6.5	4.9	2.6	.5	.5	1.3
March	4.6	4.1	6.6	6.2	3.2	.7	.9	1.4
April	4.5	4.6	4.4	10.9	2.8	.5	6.5	1.1
May	4.5	4.8	5.6	8.1	3.2	.5	3.2	1.2
June	4.9	4.3	5.5	6.8	2.7	.5	2.6	1.0
July	4.2	4.6	4.3	6.3	2.3	.5	2.5	1.0
August	4.5	5.3	6.5	6.2	3.2	.5	1.5	1.0
September	4.3	5.1	9.3	5.2	3.5	.5	.3	.9
October	4.3	4.5	8.3	5.6	3.2	.8	.7	.9
November	3.9	4.3	5.6	4.8	2.6	.7	.7	.8
December [3]	2.9	3.3	2.9	4.0	2.1	.3	.9	.7

[1] The number of additions to employment per 100 employees during the calendar month.
[2] The number of terminations per 100 employees during the calendar month.
[3] Preliminary.

Working Conditions and Earnings

Hours and Earnings

Earnings in electronics manufacturing have been traditionally lower than those in manufacturing as a whole, owing to the small proportion of skilled workers. In December 1951, hourly earnings in radio and related products manufacturing averaged $1.46 an hour, while earnings in all manufacturing averaged $1.64 an hour (table 4). Skilled workers in electronics manufacturing usually receive about the prevailing wage for their particular skill in the area in which they work. Increased military production will probably raise the industry's average earnings even if wage rates continue at 1951 levels, because a higher proportion of skilled labor will be required. Table 4 shows earnings in radio and related products manufacturing since 1947.

"Incentive pay" plans, under which a worker's earnings increase with the amount of work done, are fairly common in electronics manufacturing. Piecework is the most common incentive system, especially in parts and tube manufacturing. Group incentive plans, which provide for increased pay to every worker in a group as they increase their production as a team, are in operation in some radio and television assembly plants.

TABLE 4.—*Average hourly earnings in radio, television, and related products manufacturing compared with the all-manufacturing average, by year, 1947–50, and by month, 1951*

Year and month	All-manufacturing	Radio, television, and related products
1947: Average	$1.237	$1.133
1948: Average	1.350	1.238
1949: Average	1.401	1.283
1950: Average	1.463	1.318
1951: January	1.555	1.405
February	1.561	1.415
March	1.571	1.414
April	1.578	1.415
May	1.586	1.428
June	1.599	1.446
July	1.598	1.463
August	1.596	1.435
September	1.613	1.456
October	1.615	1.473
November	1.625	1.476
December [1]	1.635	1.460

[1] Preliminary.

In 1950, the workweek in the electronics industry was slightly longer than that in manufacturing as a whole. However, the industry's average workweek dropped below the average in all-manufacturing as radio and television receiver

production dropped off during the first half of 1951 (table 5). In normal times, the electronics industry works a 40-hour week, but during World War II, the workweek reached a peak of 46.8 hours. Average weekly hours have increased moderately with expanding defense production, but are not expected to approach World War II levels during the period of partial mobilization.

Despite heavy lay-offs in radio and television receiver manufacturing during the spring of 1951, many plant workers were on extra-shift operations in July 1951. One-seventh of all plant workers in radio, television, and related products manufacturing were employed on second or third shifts during April 1951. In electron tube manufacturing the ratio was more than 30 percent. As the defense electronics program reaches its peak and offsets the decline in civil production, there may be some increase in extra-shift work.

TABLE 5.—*Average weekly hours in radio, television, and related products manufacturing compared with the all-manufacturing average, by year, 1947–50, and by month, 1951*

Year and month	All-manufacturing	Radio, television, and related products
1947: Average	40.4	39.2
1948: Average	40.1	39.2
1949: Average	39.2	39.5
1950: Average	40.5	40.7
1951: January	41.1	40.8
February	40.9	40.5
March	41.1	40.4
April	41.0	40.1
May	40.7	40.2
June	40.7	40.4
July	40.2	39.2
August	40.3	39.9
September	40.6	40.8
October	40.5	41.0
November	40.5	41.5
December [1]	41.2	41.7

[1] Preliminary

Vacations, Pensions, and Other Benefits

Most workers in the industry receive 2 weeks' vacation with pay. Some firms give 3 weeks' vacation to employees with over 10 years' service. Almost all workers have from 6 to 10 paid holidays each year, depending upon company practice.

Almost all electronics workers are covered by some form of death benefit or sickness insurance plan. These vary widely among companies in coverage and benefits. One of the most comprehensive plans provides death benefits, group sickness and disability insurance, and hospitalization benefits up to $12 a day including provisions for some surgeons' fees. Less comprehensive programs provide other combinations of group life insurance, sickness and accident insurance, or hospitalization insurance benefits. A great majority of electronics workers are covered by some form of pension plan.

Working Conditions and Unionization

Working conditions in electronics manufacturing compare favorably with those in other industries. Plants are generally clean, well-lighted, and relatively free from noise. The work in most electronics occupations is not strenuous. However, the assembly line operations require speed, and the continual repetition of many small tasks creates monotony. Employers make an effort to help relieve this monotony of work by frequent rest periods. Cafeterias, recreational facilities, and social programs are also provided for employees, and some plants provide music during working hours.

Injuries in electronics manufacturing are less frequent and less severe than those in manufacturing as a whole. Shock from high voltages is the most serious hazard, but few workers come in contact with high voltages. Burns from soldering irons, and cuts, bruises, punctured fingers, and similar minor injuries are more common hazards.

About half the electronics plant workers belong to labor unions, but only a small proportion of office workers are organized. The principal unions in the industry are the International Union of Electrical, Radio and Machine Workers (CIO); International Brotherhood of Electrical Workers (AFL); United Electrical, Radio, and Machine Workers of America (Ind.); and the International Association of Machinists (AFL). All of these unions represent workers in several industries and their electronics membership is not known.

Plant contracts with the unions differ in requirements relating to plant employees. Some require new employees to join the union within a specified period of time. In others, membership is voluntary, but a union is designated as the workers' sole bargaining agent. Although most plants are free to hire whomever they choose, the union in some plants can reject applicants it deems unsatisfactory.

Employment Outlook

During the next few years, employment opportunities in electronics manufacturing will depend upon the volume of defense orders and the amount of critical materials available for civilian use. The many defense requirements may increase employment above previous postwar highs despite further cut-backs in civilian production because of critical materials shortages. Electronics employment is expected to be considerably greater at the peak of the current mobilization period than at the end of 1951. Thereafter, employment may decline moderately for a time when defense orders decline. However, military production is expected to continue at relatively high levels for many years and to employ more workers than before the outbreak of hostilities in Korea. Shortages of materials will gradually disappear as military production tapers off, and as the production of raw materials is expanded. This will remove the limitations on civilian production, and substantial increases in civilian electronics employment should compensate for declining employment in military production. After the defense mobilization period, electronics employment will not drop to the levels prevailing before June 1950. Eventually, employment is likely to rise above the rearmament peak.

Past Trends in Employment

During the last 30 years, employment in electronics manufacturing has increased, although there have been periodic fluctuations. With the beginning of commercial broadcasting in 1922, electronics employment increased rapidly until about 1930, dropped during the depression years, but soon recovered, and by the middle thirties exceeded the 1929 peak. Except for a short drop during the 1938–39 recession, employment continued to increase until the end of World War II. An all-time peak was reached in 1944 when an estimated 380,000 wage and salary workers were employed by military electronics equipment and components manufacturers.

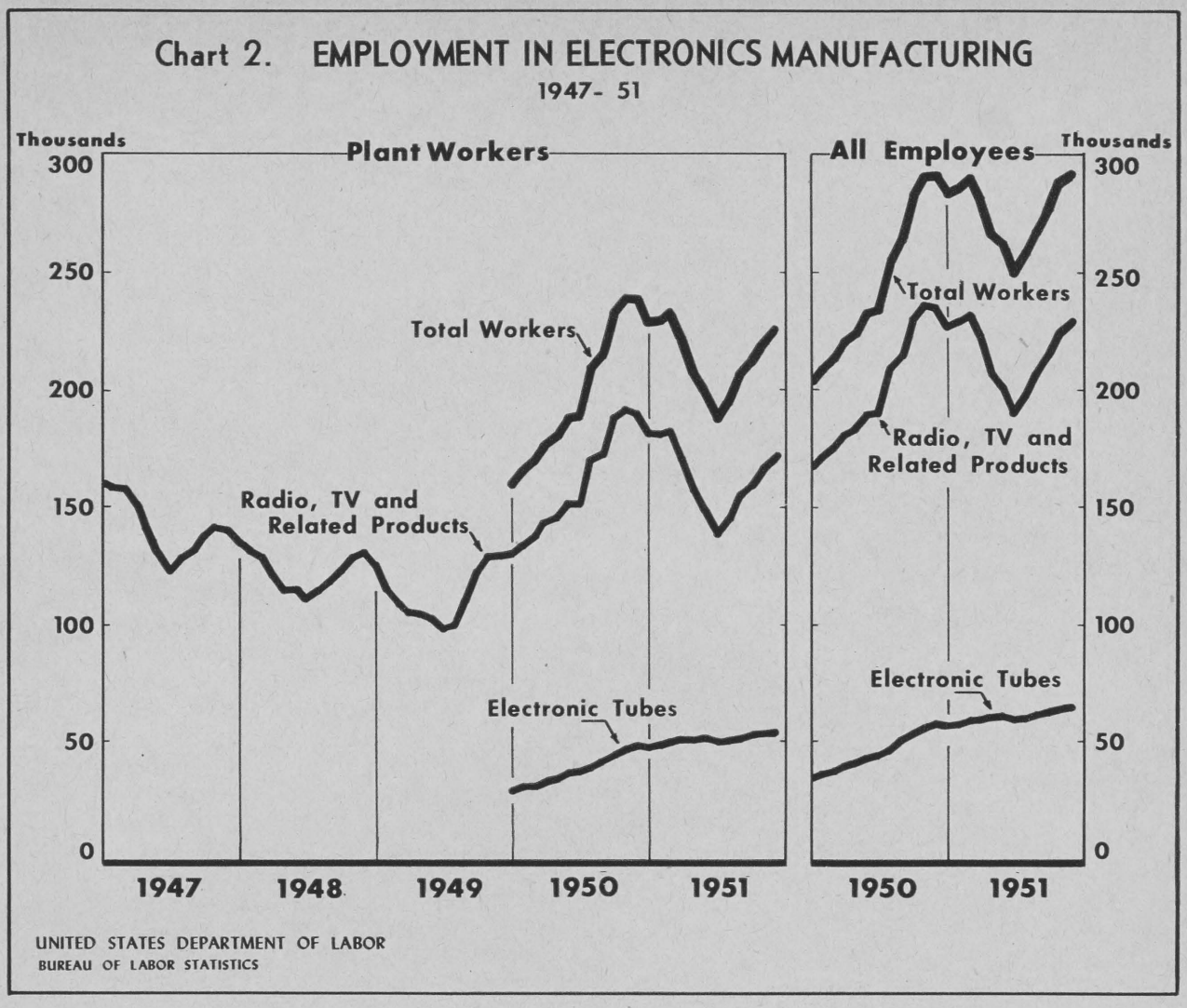
Employment dropped sharply immediately after World War II but soon recovered, and increased until 1947. Even during 1945 and 1946, when electronics manufacturers were converting from military to civilian production, the electronics employment average was higher than in 1941 and substantially higher than in 1939. Employment declined sharply in 1948 and 1949 (although the value of electronics production advanced considerably), and then began to rise steadily beginning in mid-1949. Postwar employment reached its highest level in December 1950, when 292,000 wage and salary workers were employed.

The high level of employment in the last 3 months of 1950 was due to both increased military production and record radio and television receiver production. Production of receivers exceeded sales during the first half of 1951, and as a result manufacturers curtailed production and laid off workers during the second quarter of 1951 to reduce excess inventories. Beginning with July of that year, electronics employment began to recover. Radio and television manufacturers gradually reduced their inventories and began to recall workers who had been laid off. At the same time, military equipment manufacturers were hiring increasing numbers of workers.

Increasing Demand for Electronics Products

Electronics manufacturing is a young and expanding industry. Its products are more widely used every year. The radio and television receivers used for home entertainment are the industry's principal products during normal times. The industry also makes many types of commercial and industrial electronics products which are increasing rapidly in number and value and becoming a larger part of the industry's total output. The armed services require many types of electronics products and during wartime or rearmament periods, military electronics equipment becomes the industry's principal product.

An estimated 100 million radio sets and 16 million television sets are now in use. Nation-wide broadcasting networks provide entertainment and information to the owners of these sets. Television has grown rapidly and television sets are expected in time to become almost as numerous as radio sets. To achieve this goal, manufacturers will have to produce almost four times the number of sets made so far, in addition to the



transmitters and relay stations required for a national television network. Every extension of television service to new areas increases the demand for television sets.

The demand for radio sets will also continue. Radio manufacturers and dealers have been selling to a replacement market for years, and demand is greater now than formerly. Television will probably establish a similar pattern when it reaches maturity. Color television sets will probably replace black and white receivers and greatly increase the volume of electronic components used in manufacturing. Even the periodic replacement of obsolete or worn out receivers will provide continuing employment for a significant part of the industry.

Producers of industrial and commercial electronics equipment are employing an increasing proportion of the industry's work force because there has been a rapid expansion in the use of such items. Although these products still comprise only a minor proportion of the industry's output, they are increasing in importance.

Aircraft and ships at sea use radio and radar for communication, navigation, traffic control, and avoidance of collision. Police and fire departments, taxis, and trucks use two-way radio communications to dispatch and control their vehicles. The railroads also use radio for controlling switches and locating cars in assembly yards.

Telephone and telegraph companies transmit and relay messages through electronic carrier and

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A radar unit used on a small fishing ship.

repeater systems, and send radio and television programs over these systems and their microwave relay links. International radio communications companies provide overseas radio telephone and radio telegraph service.

Electronics products are also used in medicine, research, and geological exploration. Industrial uses are becoming widespread. Public utilities use electronics carrier equipment to regulate electric power loads and automatically report damaged lines. In industry, electronic devices are used: to automatically record and regulate industrial processes; for remote control of dangerous operations; to time operations accurately; and to inspect output. Educational institutions, atomic energy plants, and the Government also use electronics equipment.

Future developments will probably greatly increase the volume and variety of industrial and commercial electronics products. For example, television offers great promise for education, office and plant intercommunication systems, and special communications operations. The Nation's telephone system may eventually become a television system. Television developments or electronic techniques yet unknown may become even more important.

Facsimile reproduction (of printed material electronically by wire or radio) is already used in the transmission of weather maps, charts, and diagrams. Techniques have been developed to send bulk printed matter such as books and newspapers by high speed facsimile processes. Facsimile reproduction can be made part of rapid printing processes whereby newspapers could be scanned in New York and simultaneously printed in Los Angeles. These and similar developments will increase the demand for many types of electronics equipment and components.

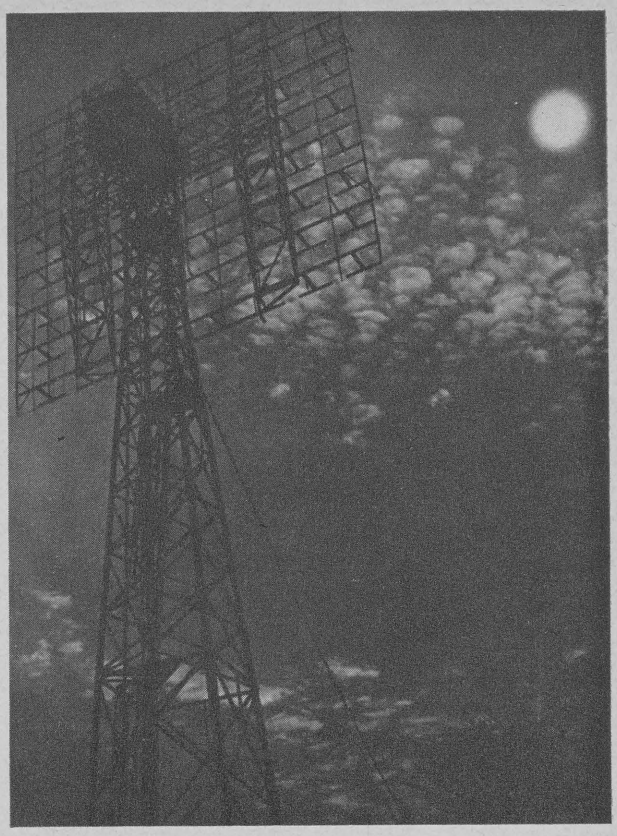
The armed services also use many types of electronic products. Modern warfare requires vast amounts of electronics equipment and the armed services will be the largest buyers of these products during the defense period. Troop communications now extend down to the patrol leader who keeps in touch with his company commander by an electronic "handie-talkie." Aircraft, tanks, ships, and other mobile weapons maintain contact with each other and their bases by radio. Even the tail gunner in an aircraft talks to his pilot over an electronic intercommunication system. Higher military headquarter's communications must handle a gigantic volume of administrative traffic in a global war involving far-flung theaters of operations and tremendous problems of troop supply. Strategic air operations require

An infantry soldier using a "handie-talkie."

world-wide collection and transmission of weather data by such means as high speed radio teletype and facsimile reproduction.

Despite the rapid growth of military communications, other military uses of electronics have assumed even greater importance. Aircraft and ships use radio and radar for navigation, to detect enemy forces, and to prevent collision with friendly craft. Air defense depends upon radar air-warning networks to rapidly locate and identify hostile forces. The interconnecting high-speed communications networks coordinate warning activities and alert friendly forces. Other radar networks guide friendly fighters to intercept enemy raids before they reach their objectives. These fighters use airborne radar to "close in" on the enemy and aim their guns. Bombers use radio and radar equipment to locate targets and aim bombs. Naval forces use radar and sonar electronic devices to detect and intercept enemy ships and submarines or to identify friendly craft. Electronic fire-control equipment is used to aim naval guns and field artillery. Electronic proximity fuzes explode shells and other missiles upon reaching their targets. Guided missiles are electronically controlled throughout their flight. Radio and radar devices are used also to detect and track storms or report weather in the upper atmosphere.

The number of electronic devices in large aircraft has quadrupled since World War II. Radio and radar equipment on some current models accounts for almost half the cost of the entire aircraft. Electronic control devices comprise most of the cost of some guided missiles. The amount of electronic equipment per man in the armed services has increased several times since World War II and will continually increase with new uses.



A radar unit capable of receiving echoes from the moon.

Changes in Technology

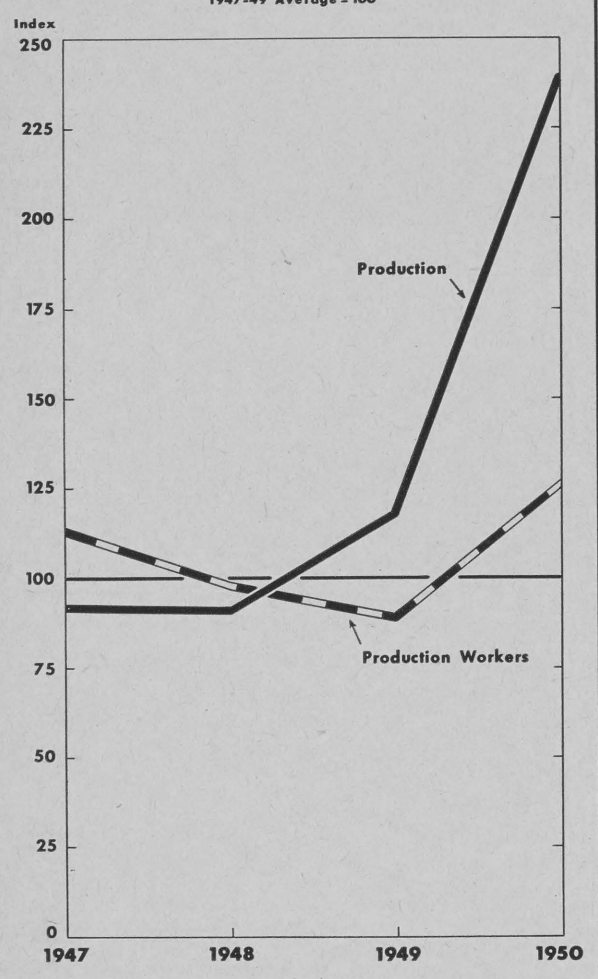
Increased demand for electronics products means increased production, and more opportunity to standardize products and economize on labor through increased use of machinery and mass-production techniques.

Manufacturing techniques have generally kept pace with the products developed by this industry. Despite the intricacy of television receivers (requiring synchronization to millionths of a second), they are assembled largely by semiskilled and unskilled labor. Almost 7.5 million television and 15 million radio receivers were produced in 1950. Many components (an average television set has some 400 electrical and 500 mechanical components) are used in several places in each set. The large volume of production of radio and television receivers and components has permitted the use of automatic processes which have not been used up to now. Already there are signs that the industry may be approaching a "technological revolution." Some basic electronic circuits are common to many products and could be made and subassembled in great quantities by automatic processes.

Several new techniques offer promise of substituting automatic or semiautomatic machine processes for hand assembly. One of these (printed circuits) makes parts and subassemblies by alternate processes of painting and baking. In this process, individual parts, such as condensers and resistors, can be made and connected by machinery.

Another process currently being developed, called component and circuit die stamping, makes small mechanical parts by automatic die stamping and wires the unit or subassembly by similar processes. This technique may permit the automatic production of complex wiring assemblies and may overcome the limitations of hand assembly, wiring, and soldering. Other automatic assembly and wiring processes now being developed may have widespread effects upon electronics employment and occupational needs. Metallic crystals, known as "transistors," may ultimately replace receiving tubes. This will greatly affect employment in plants making tubes.

Chart 3. PRODUCTION OF RADIO AND TV SETS COMPARED WITH EMPLOYMENT IN RADIO, TV, AND RELATED PRODUCTS MANUFACTURING



UNITED STATES DEPARTMENT OF LABOR
BUREAU OF LABOR STATISTICS

Source: Production Index, Federal Reserve Board

As a result of improvements in manufacturing techniques, the long run increase in electronics production will not result in a corresponding increase in employment. In 1950, the radio, television, and related products industry produced over two and a half times the 1947 output of radio and television receivers (the industry's principal product) with only 12 percent more production workers (chart 3).

Nevertheless, past experience suggests that electronics production may expand even more rapidly than labor-saving improvements. If this is the case, employment will continue to increase over the years although at a less rapid rate than production. The greatest impact of changes in manufacturing methods will probably be upon individual occupations. Automatic assembly and wiring processes currently being developed may ultimately replace many workers now employed in assembly operations and reduce the size of the industry's largest occupation. These developments will probably have an opposite effect upon the number of professional and skilled workers because any large-scale mechanization would increase the number of tool-and-die makers, machine-tool set-up men, machinists, and other skilled workers required to operate or set up the machinery. Additional production engineers would also be required to plan and organize the production flow.

Impact of Defense Production

The rearmament program will have a strong effect upon employment opportunities throughout the electronics industry. The defense program will require a dollar volume of electronics equipment almost comparable to that of World War II. However, the physical volume of equipment will be considerably less because newer equipment is more complex and expensive than World War II equipment.

Military equipment is produced in much smaller quantities than home radio and television sets and designs are changed more frequently. Over 60 percent of the value of the defense electronics program will be spent for a small number of large and expensive radar systems. As a result, there

will be less mass production and specialization of labor than in the manufacture of home radio and television sets, but more skilled labor will be required.

A large part of the electronics industry is usually engaged in home radio and television manufacturing. Many producers assemble only parts and tubes purchased from other manufacturers, and they employ only limited numbers of skilled workers and engineers. These firms are best equipped to engage in subcontracting or the mass production of standard military equipment. However, present military equipment is more complex than in World War II and standard items will be produced in much smaller quantities.

Receiver manufacturing firms may find it difficult to obtain enough military orders to offset the decline in civil production resulting from shortages of copper, aluminum, and other materials. This will directly affect employment opportunities in these firms during the partial mobilization. Full mobilization would, however, tax all assembly firms to the limit of their capacity, and additional employees would be needed to produce the volume of standard equipment required.

Firms whose main business is making aircraft, ordnance, electrical equipment, or other products other than electronics, are producing an increasing amount of military electronics equipment and adding many electronics workers. Military aircraft and other weapons contain electronics equipment which directly affects their operation and performance. The design of aircraft and other weapons and their associated electronics equipment are, therefore, closely related. This is especially true of guided missiles which are literally built around the electronic control mechanisms which guide them to their targets. For these reasons, aircraft and other nonelectronics manufacturers are expected to increase their electronics manufacturing activities.

Employment Opportunities

Employment opportunities in electronics manufacturing during the next few years will depend on the volume of defense orders and the amounts of critical materials available for civilian production. Unless the defense program is reduced or spread out over a longer period of time, military electronics production will employ large numbers of workers. Defense production was increasing rapidly at the end of 1951 and beginning to make up for lower civilian production. Although the value of military electronics production at the peak of the rearmament program will be quite large and will compare favorably with 1950 civilian production, an appreciable amount of this military production will consist of nonelectronic equipment, components, and accessories which will be made outside the industry. Thus, the resulting employment may be less than that for a comparable value of civilian electronics production.

At the end of 1951, further cut-backs in radio and television receiver production were expected during 1952 as a result of shortages of critical materials. However, even at the peak of the defense program, the electronics industry will still be making many radio and television sets. On the other hand, commercial and industrial electronics production is expected to remain relatively stable. Total employment in the industry may be greater during most of the mobilization period than it was at the 1950 peak.

Employment opportunities for electronics workers will vary widely among plants, depending upon the amount of military orders each plant has to supplement its civilian production. Plants almost entirely engaged in civilian production will have a less favorable employment outlook than plants with large military contracts. Firms making such products as aircraft, ordnance, and electrical equipment will continue to offer excellent employment opportunities for skilled electronics workers and engineers. West Coast aircraft and other military electronics producers were hiring skilled workers and engineers in eastern and midwestern electronics manufacturing areas at the end of 1951. Because of their geographical location, their recruiting program was not extended to less skilled workers.

Employment opportunities will also vary widely by occupation. Until defense production of electronics equipment approaches its peak, employment opportunities for unskilled and semiskilled workers will be less favorable than for professional and skilled workers. The latter group will be in demand throughout the partial mobilization period.

Military production is expected to remain at relatively high levels for a number of years. More

workers will be employed in this type production than before the outbreak of hostilities in Korea, even when the defense program begins to taper off. Electronics employment, however, may decline somewhat for a time as defense orders decline. Radio and television receiver production and employment will gradually increase as the supply of raw materials is expanded to the point where enough materials are available for both military and civilian needs. Although the demand for television sets may not return to 1950 levels for some time, in the long run the additional television stations which will be licensed by the Federal Communications Commission and the introduction of color television will both stimulate the demand for receivers. Receiver production and employment will then return to previous high levels. At the same time, commercial and industrial electronics equipment manufacturing is expected to increase more rapidly than other electronics manufacturing and employ a greater proportion of the industry's work force than at the present time. The combination of a relatively high level of military production and increasing civilian production may raise and sustain electronics employment above even the rearmament peak, despite continuing improvement in manufacturing techniques.

In predicting future electronics employment it must be borne in mind that electronics is a technical innovation similar to steam power or electricity. Long-run employment opportunities must be evaluated in terms of expansion involving many industries. In the long run, there should be excellent employment opportunities for all types of electronics workers. However, employment opportunities will probably vary by occupation with a declining emphasis on the skilled metalworking occupations required for military production.

Seasonal and Cyclical Variations

During the year electronics employment usually varies more than all-manufacturing employment. People buy more home radios and television sets during the fall and winter months, especially during the Christmas season. On the other hand, more automobile and portable radios are sold during spring and summer months. Employment usually reaches a peak during the fall and drops to its lowest level in mid-summer. However, this seasonal variation is not substantial and it does not apply uniformly to all electronics products or occupations.

Employment variations resulting from general business conditions are far more important. Like all durable goods, the demand for electronics products varies with the business cycle. This has been obscured by the high employment level prevailing in the postwar period, but if the economy should return to prewar conditions, some unemployment of electronics workers can be expected during periods of low business activity.

Outlook in Individual Occupations

Administrative and Executive Positions

Most electronics products are made by large firms. Therefore, there are many and varied administrative and professional positions in the industry. In addition to the management, there are salesmen, purchasing agents, production executives, personnel officials, advertising specialists, public relations men, accountants, and industrial relations men. The qualifications and duties of these positions are similar to those in other industries. Opportunities for advancement are very good in this expanding industry. Earnings depend upon the responsibility of the position and the experience of the employee.

Professional Positions

Most of the professional workers in electronics manufacturing are in technical fields such as engineering and allied activities. Electronics manufacturers employ many engineers and draftsmen, especially in the production of military equipment. In July 1951, there was 1 engineer for every 12 employees in military and commercial equipment manufacturing plants, 1 for every 21 employees in radio and television receiver plants or in electron tube plants, and 1 for every 50 employees in parts plants. Military production has already sharply increased the demand for en-

gineers, who are especially needed for research and development, designing, and retooling.

Although electronics manufacturers employ appreciable numbers of physicists, chemists, mathematicians, and metallurgists, the great majority of professional workers are engineers. Physicists and mathematicians sometimes design electron tubes and are employed in other specialized research and development jobs along with chemists and metallurgists.

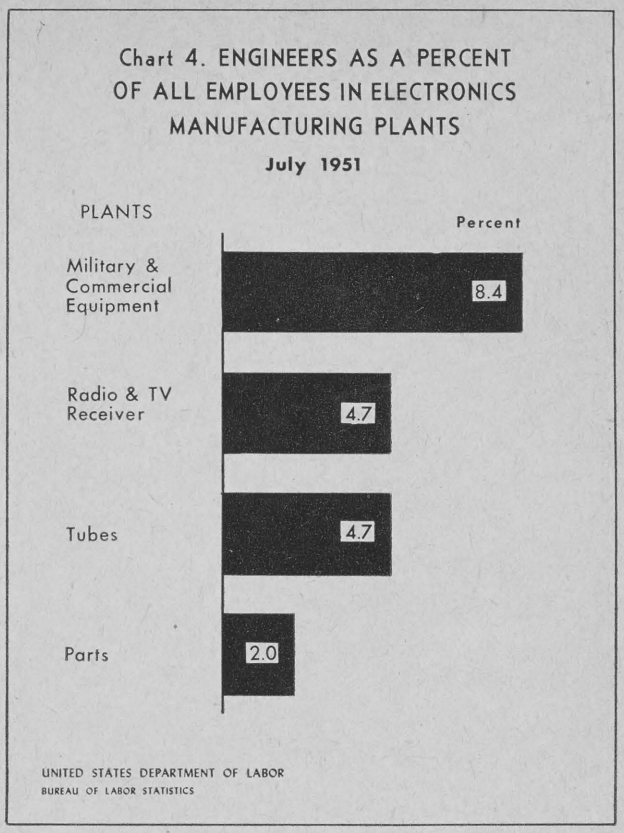
The majority of professional workers are employed in engineering departments or laboratories where they are engaged in research, development, or design. Electronics manufacturing requires continuing research and development, and some electronics manufacturers maintain extensive laboratories for pure research.

Another major group of professional workers is employed in quality control and other production jobs. The intricate flow of many components into production lines requires extensive production engineering and quality control. There is great competition in the manufacture of radio and television receivers and components, and costs are important. Production costs can be reduced by changing the design of products and improving production methods.

A smaller group of professional workers is employed in sales engineering, technical liaison with other firms or the government, or in other technical jobs outside the plant.

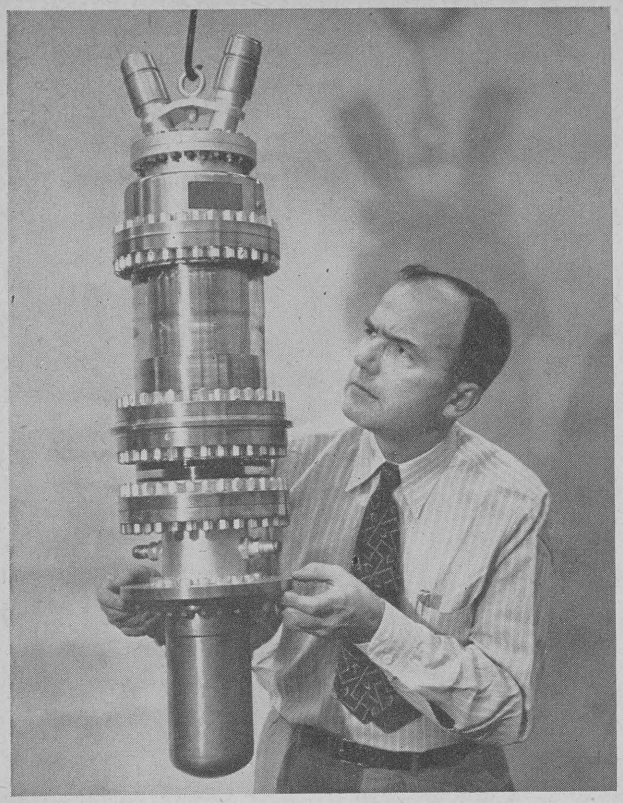
Electronics manufacturers employ several types of engineers. Electronic and other electrical engineers are most numerous, although many mechanical and industrial engineers are also employed in the industry. Electrical engineers usually have some electronics training and can be used in many circuit designing jobs. Mechanical engineers are used in mechanical designing and production engineering jobs. Industrial engineers design jigs and fixtures, make time and motion studies, analyze costs, and determine production methods.

On the average, about three times as many electronic and other electrical engineers are employed as mechanical engineers. However, military equipment and components manufacturing use a higher proportion of mechanical engineers than other electronics manufacturing. Military electronics equipment contains many mechanical components or accessories such as gear trains, servomechanisms, antenna towers or supporting structures, and heavy "hardware." Moreover, many electronic devices are used to control, or are closely associated with, other equipment or devices of mechanical nature. The design of electronic devices used to aim and fire guns, sight and release bombs, control guided missiles or aircraft in flight, or perform similar functions must be closely integrated with the design and engineering of this mechanical equipment.



Earnings of engineers depend upon the experience and education of the individual. In the summer of 1951, beginning engineers with B. A. or B. S. degrees were starting at $250 to $300 a month. Salaries have probably risen since then because of competition.

As a result of the rearmament program, employment opportunities for electronics engineers are the best since World War II. Electronics manufacturing is only one of many areas of employment requiring engineers. It is estimated that 4,000 more engineers will be required in electronics products manufacturing during the next 2 years.



A large transmitting tube used for broadcasting.

Long-range employment opportunities for engineers in electronics manufacturing are also favorable. The ratio of engineers to other electronics workers will probably continue to increase over the years. Electronics equipment is becoming more complicated. With the advent of color television, this will be true even of home television sets. Owing to the shortages of frequencies, an ever-increasing amount of electronics equipment will operate at extremely high frequencies where more research and development is required. Even when materials become plentiful, military, commercial, and industrial equipment will comprise more of the industry's output than before Korea and radio and television set production will probably no longer dominate the industry. All these trends will increase the industry's need for engineers.

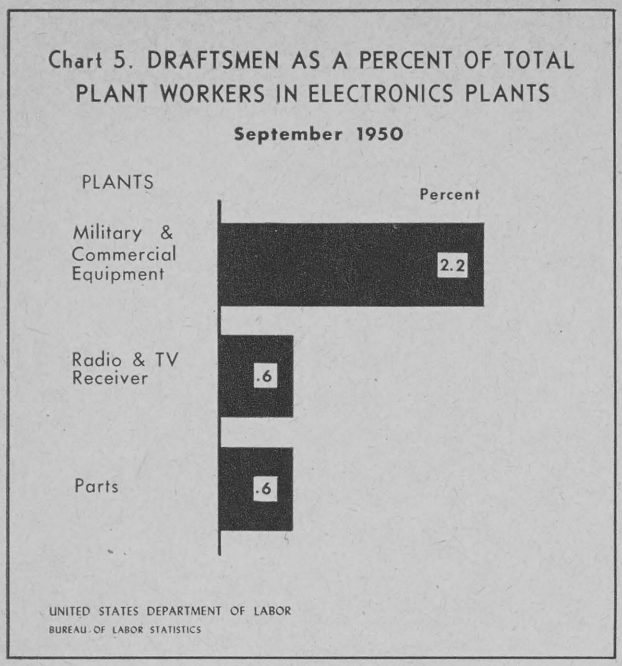
Employment opportunities for beginning engineers are also excellent. Qualified applicants should experience no great difficulty in finding employment during the next few years because of the high demand for engineers and declining graduations. However, electronic engineering requires increasing technical qualifications and knowledge. Many electronic equipments are closely integrated with mechanical devices, and training or experience in mechanical engineering is a valuable asset for electronic engineers engaged in the research, development, or production of military equipment. There is an increasing demand for electronic engineers with additional training or experience in mechanical, aeronautical, optics, ordnance, and other engineering fields. Some electronic research and development jobs require considerable training or familiarity with chemistry or physics, and engineers with such backgrounds have additional employment opportunities.

Engineers with only limited training and experience who may get jobs during the present shortage of engineers may have difficulty competing in a peacetime economy with graduates who have greater professional training. Qualified engineers graduating in the next several years should be able to find jobs even in a peacetime economy.

In the next year most job openings will be found among firms planning to enter electronics manufacturing, and especially the manufacture of military electronics products. Aircraft manufacturers and other nonelectronics manufacturers will continue to provide excellent opportunities during the defense period although, in the long run, radio and television set manufacturing may provide the greater number of openings.

Draftsmen

A higher proportion of draftsmen are required for military electronics production than for the manufacture of other types of electronics products. They are already in demand throughout the industry (chart 5). Draftsmen are usually employed in the engineering department. The industry employs both mechanical and electrical draftsmen, with the latter being more numerous. Some highly skilled draftsmen design the lay-out of parts in equipment. Employment opportunities for electronics draftsmen will be good throughout the defense period, especially in plants engaging in extensive research and development. An estimated 1,000 additional draftsmen will be needed in the next 2 years. Full mobilization would probably require two or three times as many draftsmen as are currently employed in the industry.



Long-range employment opportunities for qualified electronics draftsmen are also favorable because this occupation is expected to grow proportionally with the industry. However, with declining emphasis on defense production, fewer draftsmen will be required and workers entering the industry during the defense period with limited qualifications may experience difficulty competing with more qualified entrants. In the past, top drafting jobs were often filled by beginning engineers.

Clerical, Stenographic, and Other Office Jobs

The electronics industry employs many clerks, stenographers, bookkeepers, typists, and other office workers. Most of these jobs require some clerical experience or training. Working conditions and earnings are comparable to office work in other industries. About one out of every eight workers in the electronics industry is employed in the front office, and additional clerical workers are employed in the plants. Employment opportunities for office workers should be good for several years.

Assembly and Other Semiskilled and Unskilled Processing Jobs

Almost half of all electronics workers are employed in semiskilled or unskilled assembly or other processing jobs. Over 1,600 separate operations are required in the manufacture of a television set. These operations are performed in large part by highly specialized persons trained for single tasks. Parts and tube workers also perform highly specialized and repetitive tasks by hand or machine. Common assembly and processing occupations include assemblers, semiskilled and unskilled machine tool operators, punch-press operators, solderers, wirers, welders, semiskilled or unskilled inspectors and testers. Workers in these occupations have an opportunity to advance to higher paid jobs as working foremen.

Employment opportunities for workers desiring to enter these occupations will be generally favorable when defense production reaches high levels. Despite the greater skill requirements for military production, the great majority of workers employed in manufacturing are semiskilled and unskilled. Manufacturers of military equipment will continue to hire workers in these occupations throughout the defense period. Short-run employment opportunities will vary widely among plants and areas.

In the event of full mobilization, the volume of military production and the shortage of skilled labor would require the mass production of many military items. Jobs now performed by skilled labor would be broken down into specialized assembly and processing operations which could be performed by semiskilled and unskilled women workers. Electronics manufacturing would then require great numbers of workers for these occupations.

Long-run employment opportunities depend upon the rate of expansion of the industry and its technological developments. Automatic machinery and processes for assembling electronics products may reduce the numbers of hand assembly workers now required, but the high turn-over in these occupations will always provide some job opportunities.

Electronic Technicians

Only a small proportion of the Nation's electronic technicians are employed in electronics manufacturing. "Electronic technician" is a general title used to describe a wide variety of jobs requiring considerable experience and familiarity with basic electronic theory, circuits, and test equipment. The job titles and duties vary from

plant to plant. Many are employed in engineering departments or research laboratories as engineering aides and assistants, laboratory technicians, radio technicians, or in other jobs where they assist engineers in the construction and testing of experimental models or designs. They may also design and make specialized test equipment, induction solderers, or other equipment used in manufacturing electronics products.

Electronic technicians also help production engineers maintain the quality control so necessary in the production of a complex product. These workers are employed as quality inspectors, final testers, precision inspectors, other skilled testers and inspectors, shrinkage analysts, trouble shooters, skilled aliners and phasers, and other quality control jobs. They may also supervise less skilled workers performing similar tasks. Electronic technicians are occasionally used to assemble and test complex, specialized equipment made in small quantities and requiring special skills. In addition, electronic technicians are employed as technical representatives, field engineers, factory service technicians, or in other field installations or repair jobs.

Electronic technicians employed in manufacturing must be familiar with basic electronic theory, circuits, and the function of electrical components. They must be able to work from wiring diagrams and blueprints and be able to use the basic formulas, tables, charts, and manuals necessary for calculating circuit values. They must also know how to use testing and measuring devices, such as oscilloscopes, signal generators, and frequency meters.

Skilled electronic technicians repairing defective television receivers.

Approximately 12,000 electronic technicians are now engaged in fabricating electronics equipment in the electronics and aircraft manufacturing industries. The defense program will require at least 4,000 additional electronic technicians in electronics manufacturing during the next 2 years. Full mobilization would require several times as many as are now employed in the industry.

Employment prospects for qualified entrants will be excellent during the next few years. Most job openings will be in plants with extensive military contracts rather than in plants which are still mainly engaged in radio and television receiver production. Employment prospects will be better among plants manufacturing finished equipment than in components plants. Aircraft plants will continue to provide excellent employment opportunities for trained workers.

Qualified electronic technicians probably have better long-range employment prospects than any other skilled electronics manufacturing occupation. Only a small proportion of these highly skilled workers are employed in electronics manufacturing, and employment opportunities in other activities are improving even more rapidly than in manufacturing. Although the same basic knowledge and training required in manufacturing is needed for servicing electronics equipment, employment opportunities for trained men are in large part determined outside the industry. Service jobs depend on the volume of electronics equipment in use, which fluctuates less than manufacturing, and this tends to stabilize employment in the occupation.

Advances in the art of electronics will open up many new jobs each year, but these same advances will require higher qualifications.

Skilled Metalworking and Tooling Jobs

Of an estimated 20,000 skilled workers employed in electronics manufacturing at the end of 1951, more than half were employed as skilled machine tool operators, production machinists, platers, tool-and-die makers, machine tool set-up men, die setters, or in other skilled metalworking or tooling jobs. Approximately 3 percent of all electronics employees are working in these jobs.

Expanding defense production will require many more of these workers than will be released by cut-backs in civilian production, because military electronics requires a higher proportion of

skilled metal and tool workers than does receiver production. Electronics manufacturers are already experiencing increasing difficulty in hiring skilled workers, especially in areas with large metalworking employment. An estimated 6,000 additional skilled metal and tool workers will be required during the next 2 years in electronics manufacturing. Other defense industries require far greater numbers of these workers. As a result, the electronics industry will face sharp competition from other industries for the limited supply of qualified workers.

Full mobilization would require many of these skilled workers. Not even complete curtailment of civilian electronics production and maximum job dilution could provide enough workers, and extensive training programs would have to be undertaken.

Employment opportunities will be excellent as long as the industry has a large volume of defense orders. Should defense production of electronics equipment return to levels existing before the outbreak of hostilities in Korea employment opportunities for new entrants would become much less favorable.

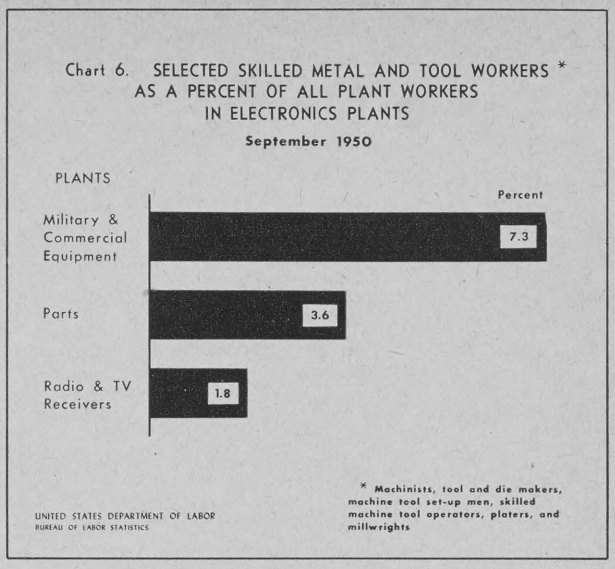
Maintenance Jobs

Less than 2 percent of all electronics workers are employed as carpenters, electricians, machinists, mechanics, and millwrights. These workers maintain electronics plants and facilities, and perform installation work.

Employment opportunities in these jobs depend almost entirely on the level of production and are only moderately affected by changes in the type of product. Long-run employment opportunities for qualified workers entering these occupations should also be favorable.

Materials Handling and Custodial Jobs

The fabrication of finished products from many small mechanical and electrical components requires extensive materials handling. Electronics manufacturing requires stock clerks, truck drivers,



truckers, packers, shipping clerks, and other workers who comprise between 5 and 10 percent of all electronics employees. Guards, janitors, and watchmen are fairly numerous and make up a larger proportion of total employees than do maintenance employees.

Duties and qualifications for these occupations are similar to their counterparts in other manufacturing industries. They require only limited training, which is usually acquired on the jobs.

The number of workers required in these occupations will depend on the industry's level of production. As the defense program boosts output, employment opportunities will increase. Military equipment requires more parts and materials handling than civilian production, and some military equipment requires special packaging, crating, and moisture-proofing. A larger proportion of these workers were employed during the last war than at present, and it is reasonable to expect a similar situation as military production increases. The security requirements of military production necessitates more guards and watchmen. Employment opportunities for most of these occupations should be favorable for the next 2 years. Long-range employment opportunities will depend on the industry's level of production.

How To Enter the Industry

Electronics employers hire most of their workers through their own personnel offices. Qualified applicants desiring electronics employment should contact these offices. Many firms have arrangements with universities and technical or trade schools which provide trained workers. The State employment service will help place prospective electronics workers and furnish them with information on local employment conditions.

Individuals planning careers in electronics manufacturing should prepare themselves for their future jobs. The type and extent of preparation, of course, will depend upon the occupation selected. Executive and professional positions usually require a college degree in engineering or business administration. Office jobs require office experience or business college training.

Persons without previous experience who wish to enter subprofessional jobs or skilled occupations can obtain qualifying training or experience by attending trade or technical schools or by becoming apprentices in the desired trade. Prospective students should select a school with a good reputation because the quality of instruction is very important. Information on trade and technical schools can be obtained from State education departments, the United States Office of Education of the Federal Security Administration, Washington 25, D. C., and educational associations, such as the National Council of Technical Schools, 2601 Sixteenth Street NW., Washington, D. C.

Persons planning to attend schools should also check with prospective employers as to the extent to which graduates are accepted as trained workers. Information on apprenticeships can be obtained by contacting employers or by writing the Bureau of Apprenticeship, United States Department of Labor, Washington 25, D. C.

Assembly and processing jobs require little preparation beyond elementary education and basic aptitudes, such as manual dexterity and an ability to follow simple instructions.

Higher executive and administrative positions are generally filled by promotion. Junior positions are usually filled by college graduates. Electronics products are highly technical. Therefore, engineering training is valuable in sales, production, and purchasing positions.

Engineering jobs are usually filled by graduates of recognized engineering schools and universities, but skilled workers and trade-school graduates are sometimes advanced into these positions. Many manufacturers prefer graduates of universities which grant degrees in radio engineering, and some prefer engineers with postgraduate training. Research and development positions generally require more academic training than production engineering positions. Only a few universities grant first degrees in radio or electronic engineering. Therefore, many electrical engineers or physicists with specialization in electronics are hired each year.

Persons planning engineering careers should complete an engineering course at a recognized engineering school or university. Information on universities, colleges, and technical schools offering engineering training can be obtained by writing the United States Office of Education, Federal Security Agency, Washington 25, D. C., or the Engineers Council for Professional Development, 25–33 West Thirty-ninth Street, New York 18, N. Y.

Electronics draftsmen require a knowledge of electrical symbols, circuits, and mathematics in addition to their basic drafting training. Experienced draftsmen can acquire this knowledge from home study. The best way to learn drafting is by attending a good vocational school or completing an apprenticeship.

For such skilled workers as machinists, tool-and-die makers, millwrights, electricians, or carpenters, apprenticeship is one of the best ways to enter the industry. These jobs are very similar to their counterparts in other industries, and previous experience in the trade is usually enough qualifying experience.

Electronic technicians need a knowledge of theoretical electronics before they can be considered skilled, and until they acquire it they can never advance very far in this occupation. This knowledge can be acquired in several ways. One can start out as a helper or apprentice and learn it on the job. Some of the best technicians are self-taught radio amateurs who acquired both the theoretical and practical aspects through home study and experimentation. This method requires ability, self-discipline, and initiative. Moreover, electronics is fast advancing beyond the home

tinkering stage and is beginning to require equipment beyond the financial abilities of most amateurs.

One of the best ways to prepare for these jobs is by attending a good trade, technical, or vocational school where one can acquire basic theory and familiarity with testing and measuring equipment.

The armed services provide excellent electronics experience and training and have excellent service schools. Young men entering the Armed Forces who are interested in electronics work should try to attend one of these schools and seek assignment to a communications group. Technicians with military electronics training are usually familiar with the types of equipment produced by manufacturers who employ the greatest number of electronic technicians. For this reason, many employers prefer workers with military electronics experience. Electronics research and development have become so expensive that military has outstripped civilian electronics development, and technicians trained in manufacturing, operating, or repairing military equipment are often the only technicians available with this experience.

In addition to the basic theoretical knowledge and familiarity with test and measuring equipment, electronic technicians need specialized practical experience which is usually acquired by on-the-job training.

Even unskilled assembly jobs require some training and the ability to distinguish colors and shapes of parts and to follow simple instructions. Applicants for such jobs are often given aptitude and personality tests to determine their fitness for employment.

The great majority of electronics manufacturing jobs require only limited training. Some firms place new workers directly on the production lines where they receive on-the-job training from experienced workers and supervisors. Other firms have special training courses and practice production lines where they prepare workers for the main assembly line.

APPENDIX I

Electronics Has Many Applications

- Entertainment:
  - Home radio and television:
    - Radio receivers.
    - Television receivers.
    - Recorders and phonographs.
    - Citizens' radio.
  - Broadcasting:
    - Radio broadcasting:
      - AM transmitters.
      - FM transmitters.
    - Television broadcasting.
    - Studio recording and sound equipment.
    - Program pickup stations.
    - Booster stations.
  - Motion pictures:
    - Sound recording.
    - Projection.
- Military electronics:
  - Ground:
    - Communications:
      - Communication centers:
        - Radio teletype.
        - Radio telephone.
        - Radio telegraph.
        - Facsimile.
      - Tactical communications.
    - Radio and radar navigational aids.
    - Air traffic control.
    - Weather observation.
    - Air warning radar.
    - Fighter control radar.
    - Armament:
      - Gun-laying equipment.
      - Guided missiles.
      - Proximity fuses.
      - Mine detectors.
  - Airborne:
    - Communications:
      - Liaison (air-ground).
      - Command (air to air).
- Military electronics—Continued
  - Airborne—Continued
    - Air navigation, radio and radar:
      - Long range.
      - Short range.
      - Instrument landing.
      - Collision warning.
    - Air traffic control:
      - Radio.
      - Radar.
    - Identification.
    - Armament:
      - Search radar.
      - Radar bombing.
      - Electronic bombsights.
      - Gun-sighting equipment.
    - Aircraft control mechanisms.
  - Shipboard:
    - Communications (radio telephone, telegraph, teletype, and facsimile):
      - Ship to shore.
      - Ship to ship.
    - Warning and detection equipment:
      - Radar:
        - Air warning.
        - Search.
        - Fighter control.
        - Collision warning.
      - Sonar.
    - Radio and radar navigation equipment.
    - Armament:
      - Gun laying.
      - Proximity fuses.
      - Guided missiles.
    - Ship control mechanisms.
- Common carrier communications:
  - International:
    - Radio telephone.
    - Radio teletype.
    - Radio telegraph.

- Common carrier communications—Continued
  - International—Continued
    - Submarine cable booster and repeater equipment.
  - Domestic:
    - Telephone repeater stations.
    - Microwave relay stations.
    - Program transmission.
    - Telephoto.
    - Facsimile.
- Transportation:
  - Ground:
    - Railroad radio.
    - Taxi radio.
    - Truck radio.
  - Water:
    - Communications (radio telephone, telegraph, and teletype):
      - Ship to shore communications.
      - Distress.
      - Weather.
      - Passenger telephone service.
    - Navigation, radio, and radar.
    - Collision warning.
  - Air:
    - Air-ground communications.
    - Traffic control.
    - Navigation.
    - Instrument landing.
    - Radio altimeters.
    - Collision warning.
- Industrial electronics:
  - Control devices:
    - Electronic timers.
    - Remote control devices.
    - Automatic control devices.
    - Inspection and quality control equipment.
    - Automatic power distribution.
- Industrial electronics—Continued
  - Industrial heating.
  - Induction solderers.
  - Intercommunication systems, office and plant.
  - Mineral and oil exploration.
  - Electronic instruments:
    - Test and measuring equipment.
    - Laboratory equipment.
  - Electronic computers.
- Government:
  - Navigational aids, air and marine.
  - Weather broadcasts.
  - Air traffic control.
  - Communications:
    - Coast Guard.
    - Weather.
    - Forestry.
    - Police.
    - Fire.
  - Weather observation.
  - Atomic energy electronic equipment.
  - Research and development:
    - Test and measuring equipment.
    - Laboratory equipment.
    - Electronic computers.
- Amateur radio, radar, and television.
- Education and research:
  - Radio and television receivers.
  - Radio and television broadcasting stations.
  - Motion picture sound equipment.
  - Laboratory equipment.
  - Test and measuring equipment.
  - Electronic computers.
- Medical electronics:
  - X–ray equipment.
  - Electron microscopes.
  - Electronic diagnosis.
  - Diathermy.

APPENDIX II

Percentage Distribution of Workers in Electronics Manufacturing, by Occupation, January 1947

Occupational group	*Percent*
All workers	100. 0
Office workers	20. 2
Administrative, executive, and professional	7. 7
Clerks, stenographers, and other office workers	12. 5
Plant workers	79. 8
Assembling	29. 3
Assemblers:	
Class A	. 4
Class B	2. 5
Class C	18. 8
Solderers	2. 9
Wirers	4. 7
Inspection and testing	8. 8
Inspectors and testers:	
Class A	1. 1
Class B	2. 1
Class C	5. 6
Metal and tool workers	5. 2
Machine tool operators:	
Class A	. 4
Class B	. 3
Class C	. 9
Miscellaneous	. 3
Machinists, production	. 2
Punch press operators	1. 6
Platers	. 2
Set-up men, machine tool	. 3
Tool and die makers	1. 0
Miscellaneous processing workers	3. 1
Painters	. 4
Welders, hand and machine	. 4
Winders, coil	1. 9
Apprentices, learners, helpers	. 1
Miscellaneous processing jobs	. 3
Working foremen	2. 0
Custodial (guards, janitors, watchmen)	1. 9
Maintenance	1. 3
Carpenters	. 2
Electricians	. 3
Machinists	. 3
Maintenance men	. 2
Mechanics	. 1
Millwrights	. 2
Materials handling	1. 3
Plant clerical	1. 1
Other plant workers	25. 8

APPENDIX III

Percentage Distribution of Professional and Skilled Workers in Radio, Television, and Related Products Manufacturing, by Occupation, September 1950 [1]

Occupation	All radio and television plants	Radio and television receiver manufacturing plants	Military and commercial equipment manufacturing plants	Parts manufacturing plants
All plant employees	100. 0	100. 0	100. 0	100. 0
Engineers [2]	3. 5	1. 8	9. 0	1. 5
Electrical	2. 7	1. 3	7. 2	1. 0
Mechanical	. 8	. 5	1. 8	. 5
Skilled metal workers	4. 1	1. 8	7. 3	3. 6
Machinists	. 5	. 3	. 9	. 4
Tool and die makers	1. 1	. 5	1. 7	1. 4
Machine-tool operators, Class A	1. 3	. 4	3. 2	. 9
Set-up men, machine tools	. 3	. 2	. 8	. 3
Platers	. 4	. 2	. 5	. 5
Millwrights	. 2	. 2	. 2	. 1
Skilled inspectors and testers (electronic technicians)	3. 0	4. 2	2. 6	2. 0
Draftsmen [2]	1. 0	. 6	2. 2	. 6

[1] Derived from information collected in the BLS Survey of Occupational Composition, September 1950.
[2] Although engineers and draftsmen are not classified as plant workers, the ratio of engineers and draftsmen to total plant workers is shown for purposes of comparison.

OCCUPATIONAL OUTLOOK PUBLICATIONS OF THE BUREAU OF LABOR STATISTICS

Studies of employment trends and opportunities in the various occupations and professions are made available by the Occupational Outlook Service of the Bureau of Labor Statistics.

These reports are for use in the vocational guidance of veterans, in assisting defense planners, in counseling young people in schools, and in guiding others considering the choice of an occupation. Schools concerned with vocational training and employers and trade-unions interested in on-the-job training have also found the reports helpful in planning programs in line with prospective employment opportunities.

Two types of reports are issued, in addition to the Occupational Outlook Handbook: *Occupational outlook bulletins* describing the long-run outlook for employment in each occupation and giving information on earnings, working conditions, and the training required.

Special reports issued from time to time on such subjects as the general employment outlook, trends in the various States, and occupational mobility.

These reports are issued as bulletins of the Bureau of Labor Statistics. Most of them may be purchased from the Superintendent of Documents, Washington 25, D. C., at the prices listed with a 25-percent discount on 100 copies or more. Those reports which are listed as free may be obtained directly from the United States Department of Labor, Bureau of Labor Statistics, Washington 25, D. C., as long as the supply lasts.

OCCUPATIONAL OUTLOOK HANDBOOK

Employment Information on Major Occupations for Use in Guidance. Bulletin 998 (1951 Revised Edition.) $3. Illus.

Includes brief reports on more than 400 occupations of interest in vocational guidance, including professions; skilled trades; clerical, sales, and service occupations; and the major types of farming. Each report describes the employment trends and outlook, the training qualifications required, earnings, and working conditions. Introductory sections summarize the major trends in population and employment and in the broad industrial and occupational groups, as background for an understanding of the individual occupations.

The Handbook is designed for use in counseling, in classes or units on occupations, in the training of counselors, and as a general reference. Its 600 pages are illustrated with 103 photographs and 85 charts.

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	Price
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Effect of Defense Program on Employment Situation in Elementary and Secondary School Teaching (Supplement to Bulletin 972, Employment Outlook for Elementary and Secondary School Teachers) (1951)	15 cents

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Factors Affecting Earnings in Chemistry and Chemical Engineering Bulletin 881 (1946)	10 cents
Occupational Outlook Information Series (by States) VA Pamphlet 7–2 (1947). (When ordering, specify State or States desired) (each)	10 cents
Employment, Education, and Earnings of American Men of Science Bulletin 1027 (1951)	45 cents
Fact Book on Manpower (1951)	Free
Employment Opportunities for Student Personnel Workers in Colleges and Universities (1951)	Free
Elementary and Secondary School Principalships—Chief Advancement Opportunity for Public School Teachers (1951)	Free
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OCCUPATIONAL OUTLOOK MAILING LIST

Schools, vocational guidance agencies, and others who wish to receive brief summaries of each new Occupational Outlook report, usually accompanied by a wall chart, may be placed on a mailing list kept for this purpose. Requests should be addressed to the Bureau of Labor Statistics, U. S. Department of Labor, Washington 25, D. C., specifying the Occupational Outlook Mailing List. Please give your postal zone number.

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